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Marketing Research Report No. 208

THE PROBABLE IMPACT OF

Milk Concentrates

ON THE FLUID MILK MARKET

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Agricultural Marketing Service

Marketing Research Division

Washington, D.C.

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THE PROBABLE IMPACT OF MILK CONCENTRATES ON THE FLUID MILK MARKET

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SUMMARY AND CONCLUSIONS

Market trials of refrigerated concentrated milk indicate that, given adequate product quality, acceptance of new concentrated milk products will depend largely on the price advantage consumers can obtain to offset real or fancied inconveniences. However, present evidence does not indicate that concentrated milk will displace a major part of fresh fluid milk.

The advantages of refrigerated concentrated milk over fresh whole milk as to costs of processing and distribution will be severely limited unless the industry obtains advantages of scale in processing and can develop specialized concentrated milk routes. Only by less frequent deliveries than at present can the fullest advantage be obtained.

Large-volume sales of concentrated milk could result in lower producer prices for Class I milk at city markets if there was competition between concentrated milk from areas with lower producer prices and milk from local sources. There probably would be a small rise in the price producers receive for milk in manufacturing milk areas. Lower distribution costs could result from fewer deliveries and larger deliveries (in terms of milk equivalents) per stop. For example, in Washington, D. C., under such favorable conditions, consumer prices might be as much as 6.75 to 11 cents per quart of milk equivalent below present retail prices for milk delivered at homes. Such price reductions would tend to force wider use of gallon containers for sales of fresh whole milk at discount prices, and similar devices which differentiate between those consumers who are primarily price conscious and those who are demanding as to service and product. These devices would slow up the market acceptance of concentrated milks, but would not necessarily result in fewer benefits to consumers.

The extent to which concentrated milk may affect producers' prices for bottling milk is dependent on (1) whether outside milk can be brought into the market, and (2) what volume of concentrated milk sales can be developed. Freight or truck costs of hauling concentrated milk will be high until sufficient volume is reached to allow regular truck-lot or car-lot shipments from the supply area to the consuming market. Competition would be insufficient to cause a change in whole milk prices until sales of concentrated milk reach a volume that is a significant percentage of whole milk sales.

If Class I or some portion of Class I prices are lowered, producers' blend prices will decline. Such a decline might have an adverse effect on local production, the extent depending on the amount of the price drop and the possibilities for alternative farm enterprises. Indirectly, such declines in production would raise manufacturing milk prices, and aid producers in manufacturing milk areas, if we assume that equilibrium exists at the outset.

Frozen concentrate appears to be a higher cost product than whole milk, and less convenient to store and handle than refrigerated or sterile concentrate. It seems doubtful that it would obtain market acceptance in volume, except for shipboard use or similar minor uses, unless costs and the level of resale prices indicated by costs can be lowered. Even for such uses, sterile concentrated and instant whole milk powder, if and when developed, appear to afford all the advantages of frozen concentrated milk at lower costs.

Instant whole milk powder should find use, particularly under circumstances where storability, weight, and bulk are factors. Army and Navy use, export trade, hunting, camping, vacations, etc. should be ideal outlets. As in the case of concentrated milk, unless whole milk powder threatened to displace a significant volume of whole milk, it would not bring about price changes in whole milk. In many markets it could be sold at prices well below present prices of milk in gallon jugs.

INTRODUCTION

Since World War II, research has been intensified on various milk concentrates that could make it possible to supply consuming areas in the East and South with low-cost milk from the dairy manufacturing areas. These concentrates include fresh, frozen, and sterile concentrated milk, and instant whole milk powder. Should such products prove practicable and gain market acceptance, they might have far-reaching effects on the prices producers receive for milk, on the location of dairy production, and on the consumption of dairy products.

A suggestion of what concentrated milk products could mean to the dairy industry may be found in the effects of frozen orange concentrate on the Florida orange industry.

The development of frozen concentrated orange juice resulted in a tremendous growth in the sale of the new concentrate--from 1 percent to 53 percent of major uses of Florida oranges within 8 years. It occurred at the time of a surge in orange production and supplied a market for the additional crop. A 66-percent increase occurred in the use of Florida oranges in major outlets and almost all of the increase was accounted for by frozen concentrate. Of the oranges sold for the major uses in the season 1946-47, 65 percent was sold as fresh fruit, 34 percent as single-strength canned juice, and only 1 percent as frozen orange concentrate. Comparable data for the 1954-55 season show 33 percent sold as fresh fruit, 14 percent as single-strength juice, and 53 percent as frozen orange concentrate.

At present, we can do little more than speculate regarding the effect which new and improved concentrated milk products might have on the dairy industry. However, we have some information as a basis for such conjectures. The information includes a report of the unsuccessful attempts to market bottled concentrated milk, status of sanitary regulations of milk, consumer attitudes toward concentrates, costs, price conditions, and status of the technological development of the new products.

THE EFFECT OF CONCENTRATING MILK ON COSTS OF BULK MILK TRANSPORTATION AND CLASS I PRICES

Transportation Costs

In concentrating fresh whole milk, a large part of its water content is removed. For this reason, the transportation costs of concentrated milk are lower than those for the equivalent quantity of whole milk. Thus, the area from which it is feasible to move milk to consumers should widen with the development of concentrated milks. If this takes place, the competition of concentrated milk from manufacturing milk areas may force down the prices paid producers for Class I milk (whole milk for fluid use) in local markets and the price of bottled milk.

An approximation of the effect of transportation costs on prices of producers' milk was developed in a report of the U. S. Department of Agriculture, "Regulations Affecting the Movement and Merchandising of Milk," Marketing Research Report No. 98 (15). Figure 1 of the above report shows the relation between distance from the manufacturing milk area and producers' prices for Class I milk. Milk could be reduced to one-third of its original volume (3-1 concentrate) in the manufacturing milk areas and shipped in bulk tank trucks to population centers at approximately one-third the cost of transporting fresh whole milk. At a distance of 500 miles from manufacturing milk areas, the difference between transportation costs for fluid milk and concentrated milk would amount to 1 cent per quart of whole milk equivalent (fig. 1). The effect would increase with distance from manufacturing milk areas.

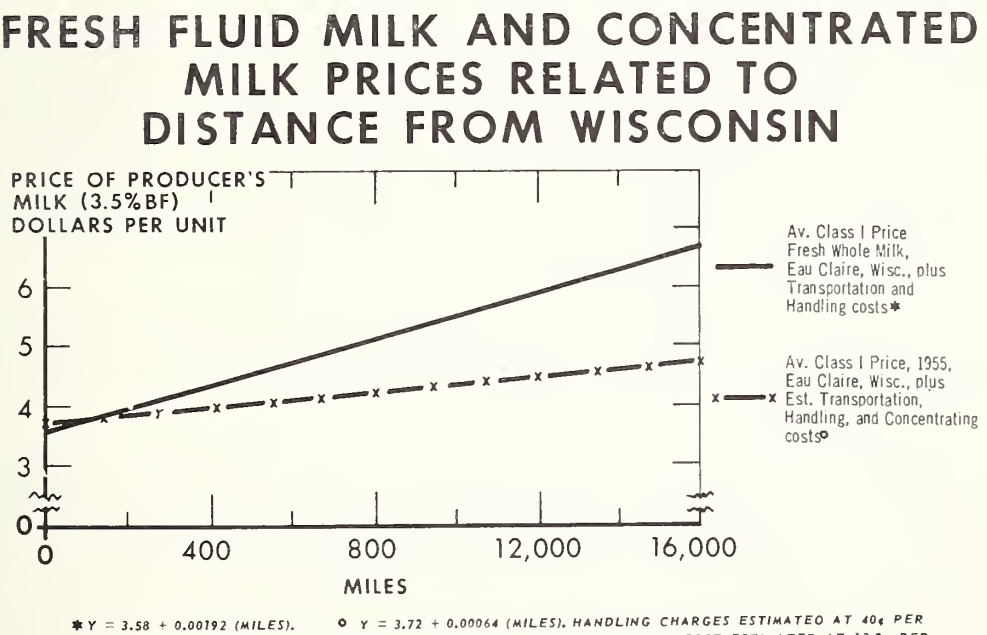
FRESH FLUID MILK AND CONCENTRATED MILK PRICES RELATED TO DISTANCE FROM WISCONSIN
PRICE OF PRODUCER'S MILK (3.5%BF) DOLLARS PER UNIT
6
5
4
3
0
0
400
800
12,000
16,000
MILES
Av. Class I Price Fresh Whole Milk, Eau Claire, Wisc., plus Transportation and Handling costs*
Av. Class I Price, 1955, Eau Claire, Wisc., plus Est. Transportation, Handling, and Concentrating costs°
* Y = 3.58 + 0.00192 (MILES).
° Y = 3.72 + 0.00064 (MILES). HANDLING CHARGES ESTIMATED AT 40¢ PER CWT. CONCENTRATED MILK OR 13.3¢ PER CWT. WHOLE MILK; CONCENTRATING COST ESTIMATED AT 13.9¢ PER CWT. WHOLE MILK (BASED ON FIG. 2, P._).
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Figure 1

Sanitary Regulations

Because of the need to retain fresh taste in concentrated milk, a temperature-time relationship is selected for pasteurization or "sterilization" that will minimize the effect on flavor. The temperature-time relations used for pasteurization must meet the standards imposed by sanitarians for the destruction of pathogenic organisms. 1/

Since concentrated milk that is merely pasteurized is about as perishable as good quality whole milk, it is obvious that the sanitary standards set for whole milk will be required for raw milk used in such concentrated milk.

The heat treatments used in concentrated milk intended to have long shelf life (the so-called "sterile" concentrated milk) are more drastic than those required for pasteurization. The method developed at Wisconsin calls for a heat treatment before concentration of 265° - 275° F. for 3 seconds, and a second treatment, after concentrating, of 220° F. for 3 seconds (4). These treatments resulted in a concentrated milk with an average bacteria count below 1 colony per ml. (standard plate-count method).

This heat treatment is less severe than the commercial sterilization used for evaporated milk. Apparently some bacteria and spores are able to survive and, after a period of time, the product deteriorates.

Because the number of surviving bacteria and spores tends to be larger when the bacterial population of the raw milk is high than when it is low, it is likely that standards equal to those for Grade A milk will be required for raw milk used in either refrigerated or sterile concentrated milk.

Previous research indicates that Grade A requirements would not necessarily be an impediment to the movement of concentrated milk and, therefore, to the effect of such movement on producers' prices for Class I milk used in city markets. In Marketing Research Report No. 98, Department specialists concluded that, except for relatively few "protected" markets, sanitary regulations did not generally inhibit the movement of Grade A milk, and that the sanitary barriers that did exist were lessening (15, p. vii).

The greatest possible impact of concentrated milk could occur in sheltered markets where sanitary regulations, economic regulations, or other restrictions result in prices which differ from those in areas of heavy production by more than the cost of transportation.

Where restrictions have caused unusually high Class I prices, attempts to restrict the entry of outside concentrated milk could be expected. However, the availability of low-priced concentrated milk would bring greater economic pressure against such restrictions, which would increase the chances of overcoming them.

1/ The Iowa method pasteurized the concentrate at 180° F. for 16 seconds (18).

Producers' Prices

If we assume that sanitary regulations would pose no hindrance to the flow of concentrated milk, the lowered transportation costs of concentrated milk could be expected to affect prices of locally produced milk in proportion to the extent that concentrated milk can displace whole milk. If sales of concentrated milk at lower retail prices displaced a large proportion of fresh whole milk sales in a market, and this trend continued, local Class I prices probably would be lowered to meet the competition. Until sales of outside concentrated milk rose to a point where they seriously threatened local producers' sales of Class I milk, it is unlikely that Class I prices would be reduced to meet this competition.

In the absence of a formal method of arriving at the Class I price, local producers and handlers might, by bargaining, arrive at a price between the old Class I price and the f.o.b. market price of bulk concentrated milk entering the market from outside sources.

In markets where prices are established under a classified pricing plan milk used for concentrated milk in fluid uses could be put into a separate class with its price differing from that of milk used for fresh fluid purposes, by the difference in transportation costs between concentrated and fresh fluid milk from the marginal supply point. 2/

Unpublished research by the Agricultural Marketing Service shows that under Federal milk marketing orders Grade A requirements and transportation costs are the major factors that decide the class assigned to utilization for specific products. Sanitary requirements for concentrated milk are equivalent to those for fresh whole milk, but transportation costs for concentrated milk, like those of cream, are below those for fresh whole milk. This difference in transportation costs might be considered a basis for establishing a separate class for receipts used for concentrated milk.

THE EFFECT OF CONCENTRATED MILK ON PROCESSING AND DISTRIBUTING COSTS

Refrigerated Concentrated Milk

Effect on Processing Costs

Concentrated milk is fresh whole milk which is concentrated in a vacuum pan to one-third of its original volume. Extra heat treatment during processing gives concentrated milk keeping qualities that often are regarded as above

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2/ The marginal supply point is the perimeter of the supply area for a market where the differential between the price paid producers for milk sold to manufacturing outlets and that for milk sold for fluid milk plants is such that it is a matter of indifference to the producer whether he ships his milk to a manufacturing outlet or a fluid milk plant.

those of fresh whole milk. After concentrating, the milk is processed, packaged, and refrigerated in approximately the same manner as fresh whole milk.

Processing costs for concentrated milk can be expected to vary from those of fresh fluid milk because concentrating is an added operation, and it lessens the volume of milk to receive further processing and packaging.

The costs of concentrating reported in an Iowa Agricultural Experiment Station publication, "Methods and Costs of Processing and Delivering Fresh Concentrated Milk in Rural Areas," (18), were $53.68 for 15,000 quarts of 3-1 concentrated milk, or 0.36 cent per quart of concentrated milk, and 0.12 cent per quart of whole milk equivalent. 3/ The cost per quart of processing and packaging in that study was shown to be constant regardless of volume at 1.632 cents per quart. The container cost was reported as 2.1 cents per quart.

For a 3-1 concentrate, the volume of milk is reduced to one-third of the original volume, and processing costs subsequent to concentrating as well as packaging costs are reduced accordingly, below those of the equivalent amount of whole milk. The Iowa study showed that the cost of processing and packaging per quart of milk equivalent was reduced 2.13 cents.

The costs reported in the Iowa study were for small scale operations, 750 to 15,000 quarts of concentrated milk per week. These unit costs, as reported, did not vary with changes in volume. In large milk bottling plants where economies of scale result in processing and packaging costs below those of the Iowa plant, savings per unit brought about by a shift to concentrated milk might be lower than those reported in Iowa.

Research data, January-March 1955 (to be published by U. S. Department of Agriculture), show that container filling and handling costs for a group of plants processing 4.5 million units annually in paper were 1.93 cents per unit, as compared with 2.14 cents for plants handling 1.5 million units annually. Container costs were practically constant for various sizes of large plants at approximately 1.6 cents.

For plants as large as these, a shift to concentrated milk would cause a fall in processing costs of 1.2 cents per quart of milk equivalent.

Container costs for 3 quarts of milk equivalent would be lowered from 4.8 cents to 1.6 cents which is a saving of 1.1 cents per quart of milk equivalent.

Total savings would approximate changes in processing and container costs less the additional cost of concentrating, or 1.2 cents plus 1.1 cents less 0.3 cent. Thus, total savings in packaging and processing would be about 2 cents per quart of milk equivalent for large-volume plants.

3/ The facilities for concentrating were in the plant. If concentrating facilities must be added to a fluid milk plant, the concentrating costs would rise to about 0.7 cent in the size of plant under consideration.

Ward and Cook, basing their estimates on a number of cost studies with costs adjusted to the 1954 level, considered that the maximum saving possible in processing costs would be about 2.5 cents per quart of concentrated milk, and that container costs would be reduced 3.6 cents per quart of concentrated milk (19). Since they calculated that concentrating in large-scale plants would cost 0.94 cent per quart of concentrated milk, or 0.313 cent per quart of milk equivalent, the total possible savings would amount to 5.06 cents per quart of concentrated milk, or 1.69 cents per quart of milk equivalent, according to their estimates.

A shift from whole milk to concentrated milk in an existing plant could result in a large amount of excess capacity in equipment and buildings. Fixed costs of buildings and equipment could be reduced by liquidating some equipment not needed in handling concentrated milk. Alternatively, unit fixed costs could be reduced by increasing output (in terms of milk equivalent) beyond the previous volume.

It is possible that the reduced volume of finished product resulting from the shift might result in higher variable costs per unit than if the plant were operated at its planned volume. This could occur if the change resulted in a less complete utilization of labor than under the original volume.

The costs as discussed here represent the results of a complete shift from a volume of whole milk to the equivalent volume of concentrated milk.

It is obvious that savings in processing and packaging made possible by handling concentrated milk would not occur if the bottling plant bought concentrated milk, reconstituted it to its original volume, and bottled the reconstituted milk for distribution in that form.

Effect on Distribution Costs 4/

Indications from previous experience in the delivery of refrigerated concentrated milk are that its introduction raised rather than lowered distribution costs. This increase was due to the fact that it was introduced as an additional product on existing routes. Spencer and Scott considered that savings would not be realized unless sales of concentrated milk reached 20 percent of fluid sales in a market (13).

It is possible, however, that reductions in distribution costs could be obtained with a smaller percentage of fluid milk sales, provided concentrated milk sales in the market were made by a single milk distributor. The market

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4/ It is unnecessary to discuss the effect on distribution costs of distributing reconstituted concentrated milk, because it would be handled in the same manner as fresh whole milk.

must be sufficiently large for the distributor to have enough volume to obtain economies in processing and distribution available through large-volume operations. His delivery routes would have to specialize in concentrated milk without unduly reducing the number of customers per block or mile on his routes.

Consumers would benefit from reduced costs only if the distributor's position in the market were strong enough to enable him to price concentrated milk in accordance with marketing costs.

The amount of cost reduction possible in milk distribution depends largely on whether the existing frequency of deliveries is maintained or whether the number of deliveries per week can be reduced.

Cost reductions under conventional delivery methods.--With conventional delivery methods, concentrated milk would be delivered as fresh whole milk deliveries now are: Daily, every-other-day, or three times weekly. Under these conditions, retail concentrated milk routes would show inconsequential savings over whole milk routes. Costs of a retail milk route are a function of the number of calls rather than a function of the volume delivered (7, p. 5). Thus, two packages of concentrated milk would cost about the same to deliver to one stop as six packages of whole milk.

In wholesale delivery, 15 to 18 percent of the cost depends on the size of the delivery (3, p. 167; 8, p. 19; 11, p. 14). In Minneapolis, the cost of a single wholesale delivery was as follows:

Size of delivery	Delivery costs	
	Per delivery	Per quart of milk
	Dollars	Cents
10 quarts	1.064	10.64
30 quarts	1.151	3.84
50 quarts	1.239	2.48
150 quarts	1.677	1.12
200 quarts	1.896	0.95

Since a quart package of concentrate involves distribution of the same milk equivalent as 3 quarts of whole milk, it is logical to assume that 10 quarts of concentrate would replace a delivery of 30 quarts of whole milk; 50 quarts, a delivery of 150 quarts of whole milk. On the basis of the above costs, the savings, because of smaller deliveries, would amount to about 0.3 cent per quart of milk equivalent for delivery of 10 quarts of concentrated milk and about the same for a delivery of 50 quarts of concentrated milk.

The average size of wholesale delivery indicated by the Minneapolis study was roughly 50 quarts (47.7 quarts). These estimated savings assume that milk truck drivers' commissions continue on a milk equivalent basis rather than a per package basis.

Cost reductions under less frequent delivery.--Since concentrated milk has longer keeping quality than whole milk and requires less refrigerator space, it should be feasible to deliver milk less often than at present without expanding present store and home facilities. Deliveries to homes might be reduced from the present three times per week, or every-other-day, to one time weekly. Deliveries to stores could be made twice weekly instead of daily.

In this manner, the cost of both retail and wholesale deliveries of concentrated milk could be reduced to about one-third present costs. Savings would approximate 4.3 cents per package of whole milk equivalent at homes and 1.7 cents at stores (8, p. 12).

Cost reductions in retail stores.--The amount of cost savings in retail stores possible through handling concentrated milk instead of whole milk would vary considerably from store to store, dependent on services offered by the milk drivers and merchandising practices in the store. Safeway Stores reported savings amounting to 1.5 cents per quart of concentrated milk, or 0.5 cent per quart of milk equivalent (19, pp. 30-31).

Instant Whole Milk Powder

Increasing emphasis is being placed on the need for Grade A milk for drying purposes. Sanitation regulations in some cities require that nonfat dry milk used in ice cream, cottage cheese, or for reconstituted milk, be made of Grade A milk. The recent concern about enterotoxins in reconstituted milk stresses the need for attention to the quality of milk used in nonfat dry milk. Thus, there is a trend toward higher sanitary requirements for milk used for powder. It seems probable that Grade A milk ultimately will be required for milk used in instant whole milk intended primarily for reconstitution for beverage purposes.

Costs of drying whole milk powder have not been published, and instant whole milk powder, sufficiently stable for general distribution, has not reached the market, hence retail prices and margins are not known. However, prices paid producers for milk used in manufacturing, as well as wholesale prices of whole milk powder, are published. In the absence of other information, it can be assumed that the cost of packaging whole milk powder for retail distribution and the distribution costs would approximate the margins taken for these functions for nonfat dry milk. Margins for nonfat dry milk are not published, but the product is sold at retail, so retail prices can be obtained.

In Washington, D. C., in May 1957, a 1-pound 9.6-ounce package of instant nonfat dry milk could be purchased in chainstores for 63 cents, as compared with the U. S. average plant price of 24.78 cents for the equivalent amount of spray

process nonfat dry milk. 5/ Thus, packaging and distribution cost about 38.2 cents for 1 pound 9.6 ounces of nonfat dry milk. We assume that the required margin would be about the same for instant whole milk powder.

The average U. S. manufacturers' price of whole milk powder for April-May 1957, was 32.64 cents per pound, or 52.2 cents for 1 pound 9.6 ounces. 6/ The manufacturers' price, 52.2 cents, plus the distribution margin of 38.2 cents, gives an approximate retail price of 90.4 cents for a 1-pound 9.6-ounce package. Since this size package would make about 6 quarts of reconstituted whole milk, the retail price per quart of milk equivalent would approximate 15 cents. 7/ This approximation assumes that (1) the cost of making instant whole milk powder would be no greater than that of making the present type of whole milk powder, and (2) no greater costs would be involved in obtaining a satisfactory shelf life than are necessary in making the present type of whole milk powder and packaging nonfat dry milk.

These assumptions are open to question. It is not known whether or not it will be possible to produce instant whole milk powder commercially, at the same cost as present whole milk powder. Neither is it known whether a commercial process or packaging method is possible that will ensure adequate storage life for retail instant whole milk powder and result in no greater margins than those above.

Sterile Concentrated Milk

Considerable research has been directed toward developing a process to produce a fluid concentrated milk that retains the flavor of whole milk and has a shelf life long enough for it to be handled as a staple product in stores. As yet, a satisfactory product has not reached the market. Such a product, often called "sterile" concentrated milk, could make it possible for milk to move from low-cost production areas through food store channels to consumers at lower distribution costs than are possible with other fresh-tasting fluid milk products. By making possible sharp reductions in consumer price, sterile concentrated milk might widen the market for milk.

The distribution methods envisaged for sterile concentrate, i.e., through food stores, are the same as those used for evaporated milk. Also like evaporated milk, sterile concentrated milk would be packaged in cans, though the size of can may differ from the 14 1/2-ounce can used for evaporated milk.

5/ Crop Reporting Board, Agricultural Marketing Service. Evaporated, Condensed, and Dry Milk Reports for January, February, March, and April 1957. U. S. Dept. Agr. (Processed.)

6/ Ibid., for May and June 1957.

7/ Calculated on the basis of 97 percent solids in the whole milk powder and 12 1/2 percent total solids in the reconstituted whole milk.

Evaporated milk is fresh whole milk which has been concentrated to one-half its original volume; whereas concentrated milk has been reduced to one-third. Thus, the cost of removing water from concentrated milk would be higher than that for evaporated milk. On the other hand the distribution costs for a can of sterile concentrated milk probably would be similar to that for a can of evaporated milk of the same size. On a milk equivalent basis, therefore, sterile concentrated milk would have slightly lower distribution costs than evaporated milk.

Unfortunately, no published data are available to show the cost of evaporating and distributing evaporated milk. However, margin data for evaporated milk are published by the U. S. Department of Agriculture. Margins show the difference per unit, in this case, per 14 1/2-ounce can, between the price paid by consumers and the net prices received by farmers. Both costs and returns to management are included in margins.

The average margin for evaporated milk reported by the U. S. Department of Agriculture for 1956 was 7.8 cents per 14 1/2-ounce can (16). On a whole milk equivalent basis, this margin approximates 8.6 cents per quart.

One and one-third times as much water must be removed from milk used for 3-1 concentrated milk as from milk used for evaporated milk. Therefore, it is assumed that costs for evaporating are about 75 percent as much as for concentrating 3-1 milk. Concentrating costs have been estimated as 0.313 cent per quart of milk equivalent (page 7).

Because the volume of 3-1 sterile concentrate would be only about two-thirds of the same milk equivalent after evaporating, it is logical to assume that handling, packaging, and distributing costs for concentrated milk would approximate two-thirds of the same cost items for evaporated milk.

The adjustments made in the 1956 margins for evaporated milk to reflect these differences in processing and handling are shown below. The resulting estimated margin for sterile concentrated milk is 5.9 cents per quart of milk equivalent.

Item	Margins per quart of milk equivalent
1956 average margins for evaporated milk	8.611
Less cost of evaporating (3/4 cost of concentrating, 0.313¢ x .75)	0.235
Estimated margin for handling and distributing	8.376
Two-thirds' margin for handling and distributing	5.584
Plus cost of concentrating 3-1 milk	0.313
Estimated margin for processing, handling, and distributing 3-1 concentrated milk	5.897

Should concentrated milk be packaged in cans other than the 14 1/2-ounce size used for evaporated milk, the costs would vary somewhat from those of evaporated milk. Also, a need to use refrigerated space for sterile concentrated milk would increase costs of distributing it above those for evaporated milk.

The possibilities of added costs of this kind suggest that the estimate for margins for sterile concentrated milk be increased from 5.9 cents to 7.0 cents per quart of whole milk equivalent.

Possible differences in the industries' structures could also affect distribution costs and, therefore, the accuracy of the estimated margins.

The evaporated industry has established zones within which delivered prices of evaporated milk are uniform, regardless of the distance between the plant and the buyer. Because capital costs involved in evaporating milk are high, it is an industry in which economies of scale have resulted in the development of large-volume plants. Despite the cost of transporting evaporated milk from plant to consuming areas, these large plants have located in manufacturing milk areas in order to assure themselves of adequate, as well as low-cost supplies of raw milk.

Should the development of a concentrating industry located in manufacturing areas cause larger amounts of milk in market milk areas of the East and South to be used in the lower-valued manufactured products, there would be a distinct possibility that, because of transportation differentials between milk manufacturing areas and consuming areas, concentrating plants would take advantage of this supply of milk and locate in consuming areas. Because even concentrated milk is bulky and expensive to transport, differentials in margins due to the distance between the manufacturing areas and consuming areas might enable relatively small-scale, high-cost local concentrating plants to develop in locations where the producer prices would be lower than producer prices in the manufacturing areas plus transportation costs. Under such conditions, margins would vary from market to market, possibly, but not necessarily, in accord with transportation costs from milk manufacturing areas.

Frozen Concentrated Milk 8/

Frozen concentrated milk has not yet reached the general public. Both the Army and Navy have bought relatively small quantities of the product for research purposes. In England and Denmark, frozen concentrated milk is reported to be produced commercially for use on shipboard. Frozen concentrated milk is fresh whole milk from which usually about 7.7 percent of the water has been removed and the concentrate frozen. When mixed with two parts of water, it makes a whole milk of original composition.

8/ This section of the report, with a few minor changes, was published previously as part of an article, "The Outlook for Frozen Foods," Marketing and Transportation Situation, U. S. Dept. Agr., Nov. 1956.

Research in recent years by the Dairy Products Section of the Eastern Utilization Research and Development Division of the U. S. Department of Agriculture indicates that frozen concentrated milk retains its flavor and body for a period of 2 to 3 months if stored at minus 10° F., and longer if held at a lower temperature (2).

Though the keeping quality of frozen concentrated milk is satisfactory, available information indicates that the concentrate is a more costly product under present shipping, packaging, and distributing methods than fresh fluid milk. On one Navy contract, the cost of frozen concentrated milk equivalent to 1 quart of whole milk was 20.4 cents laid down in Norfolk, Va. The frozen product was made from raw milk costing $3.34 per 100 pounds. Another Navy contract specified 23.0 cents delivered at Bayonne, N. J. This frozen concentrated milk was packaged in quart paper containers and shipped in export boxes. The prices are based on large-lot deliveries and are about the same as those one might expect for frozen concentrated milk shipped from dairy product manufacturing areas into eastern markets or made from surplus milk in a city market. These prices do not include any costs for distribution to stores or to consumers. They include profit, if any, for the contracting firm.

No information is available as to the cost of distributing frozen concentrated milk. It is known that many frozen food distributors sell to institutions, stores, and other buyers at margins of about 15 percent of the wholesale selling price. Platform prices of 20.4 cents per quart of whole milk equivalent would approximate 61 cents per quart of frozen concentrated milk. Assuming a 15-percent margin, the prices of frozen milk delivered to stores would be approximately 72 cents per quart, or 24 cents per quart of milk equivalent.

The average percentage gross margin on purchase cost that stores take on milk has been reported as about 10 percent. On the basis of an average margin of 10 percent, the price consumers would pay for frozen concentrated milk would be about 26 cents per quart of milk equivalent. These estimated prices compare with the 1956 United States average price for fresh whole milk of 22.6 cents per quart at stores (17). Processing and distribution costs might be lowered if large-scale sales developed.

Present indications are that if frozen concentrated milk were made available to the public it would be sold to consumers by retail stores and frozen food plans. Retail stores could be supplied by either dairy companies or frozen food distributors.

Even a small shift from fresh milk consumption to frozen milk would have a significant effect on the total tonnage of frozen food sold in this country. One percent of the fluid milk and cream consumption in the form of a 3-1 concentrate would amount to nearly 97,000 tons of frozen concentrated milk per year, roughly 3 percent of the total frozen food tonnage produced in 1955.

Any great increase in retail sales of frozen concentrated milk appears unlikely unless new and lower cost methods of processing and distributing are found. Its present opportunities appear greatest in markets in which prices are substantially above the national average. Frozen concentrated milk appears to have possibilities for use on shipboard where subzero storage space is available and a premium is placed on compactness and keeping quality.

Frozen concentrated milk would be in competition with unfrozen milk concentrate, which cannot be kept as long as the frozen product but requires less expensive refrigeration.

Frozen concentrated milk would have little or no advantage over instant dry whole milk or sterile concentrated milk, should these products be developed in satisfactory form.

RETAIL PRICES FOR FRESH FLUID MILK AND ESTIMATES OF RETAIL PRICES FOR CONCENTRATED MILKS

If all cost reductions in milk processing and distribution were to be completely reflected in reduced consumer prices, one could estimate the relative retail prices for fresh fluid milk and its concentrated substitutes. This assumption implies that there are no barriers to the movement of milk from milk manufacturing areas. An added assumption is that a sufficient volume of concentrated milk would be marketed to make it possible to attain the indicated economies if the concentrated milk sales were made by one handler. The handler must be able to absorb tank truck lots of concentrated milk from milk manufacturing areas. Assuming per capita milk consumption to be 0.9 pint daily, a 30,000-pound tank truck load of concentrated milk per day would supply about 90,000 consumers. A plant this size would market roughly 5 million quarts of milk equivalent per year.

To obtain cost reductions in distributing concentrated milk, the handler would need to operate specialized routes on which all or nearly all deliveries were deliveries of concentrated milk. On these routes, the number of customers per block or per mile and the distance traveled would be expected to approximate that of customers for fresh whole milk.

The Washington, D. C., market may be used to illustrate the possible impact of concentrated milks on consumer prices. The Washington price for fluid milk used for bottling purposes (February 1957) was $6.22, plus a 40-cent premium for quality, or 14.24 cents per quart. The producers' price for milk in multiunit containers sold in stores was the equivalent of about 1 1/4 cents per quart below the price for milk in other containers, or 13.0 cents per quart.

Based on figure 1, the cost of concentrated milk delivered to Washington would be about $4.40 per hundred pounds, or 9.46 cents per quart of whole milk equivalent.

These figures and the cost figures shown in previous parts of the study were used to develop table 1.

These estimates show that the development of large-scale sales of concentrated milk, except frozen concentrated milk, could result in the availability of fluid milk to consumers at prices considerably below the prices of fresh whole milk in many cities.

The sharp reduction in producer prices is partially due to the high Class I price in Washington, compared with prices in the manufacturing areas, and transportation costs. This reduction would be much less in the many cities with lower Class I prices.

There is little difference between the estimates of the consumer prices for refrigerated milk, sterile concentrated milk, and instant dry whole milk.

It must be emphasized that these are estimates of the lowest prices that would be attained with efficient processing and distribution. A change in technology could give an advantage to any of the products.

THE EFFECT OF CONCENTRATED MILK ON THE STRUCTURE OF THE DAIRY INDUSTRY

Several factors indicate that if large-scale sales of concentrated milk develop the marketing of concentrated milk is likely to be carried on by existing dairy firms: (1) Dairy firms already have facilities for receiving and handling milk and may be equipped to concentrate or process and package milk; (2) the dairy industry already has an established delivery system which can handle concentrated products and can be adapted readily to do so more efficiently; and (3) it is difficult and costly for a new firm to develop an adequate supply of farm milk in competition with existing plants.

Economies of scale in concentrating favor the establishment of large plants (fig. 2). A plant could be set up to concentrate 216,000 pounds of milk daily for 13.9 cents per hundred pounds of whole milk, as compared with about 26.2 cents per hundred pounds of milk for a 40,000-pound plant, and about 70 cents per hundred pounds of whole milk for a 6,000-pound plant (fig. 2).

The location of the concentrating facilities would affect the location of supply areas for consuming centers.

The inducement for introducing concentrated milks is greater for plants in manufacturing milk areas than for plants in the fluid milk consuming areas, since concentrated milk offers the former plants a higher value outlet than manufacturing uses of milk. The relatively low availability of producer milk close to consuming areas, at least until concentrated milk displaces Class I milk, also favors initially the establishment of large-scale concentrating plants in manufacturing milk areas where large concentrations of Grade A, or potentially Grade A, milk are used for manufacturing purposes.

Table 1.--Estimates of the relative consumer prices of fresh whole milk and concentrated milks, based on Washington, D. C., prices, February 1957

Product	Estimated reduction due to lower:				Estimated total reduction below single quart price		Estimated consumer prices	
	Producer milk prices	Processing and packaging costs	Distribution costs: To homes	Distribution costs: To stores	At homes	In stores	At homes	In stores
	Cents per quart whole milk equivalent							
Single quarts, fresh whole milk	---	---	---	---	---	---	26	22
Multiunit packages, fresh whole milk	1/1.25	---	2/2.0	3/1.25	2/2.0	3/2.5	2/24.0	19.5
3-1 refrigerated concentrated milk								
Conventional delivery	4.75	2.0	---	0.3	6.75	5.8	19.25	16.2
Less frequent delivery	4.75	2.0	4.3	1.7	11.0	7.2	15.0	14.8
3-1 sterile concentrated milk	4/	4/	---	4/	---	7.3	---	14.7
3-1 frozen concentrated milk	4/	4/	---	4/	---	-4.0	---	26.0
Instant dry whole milk	4/	4/	---	4/	---	7.0	---	15.0

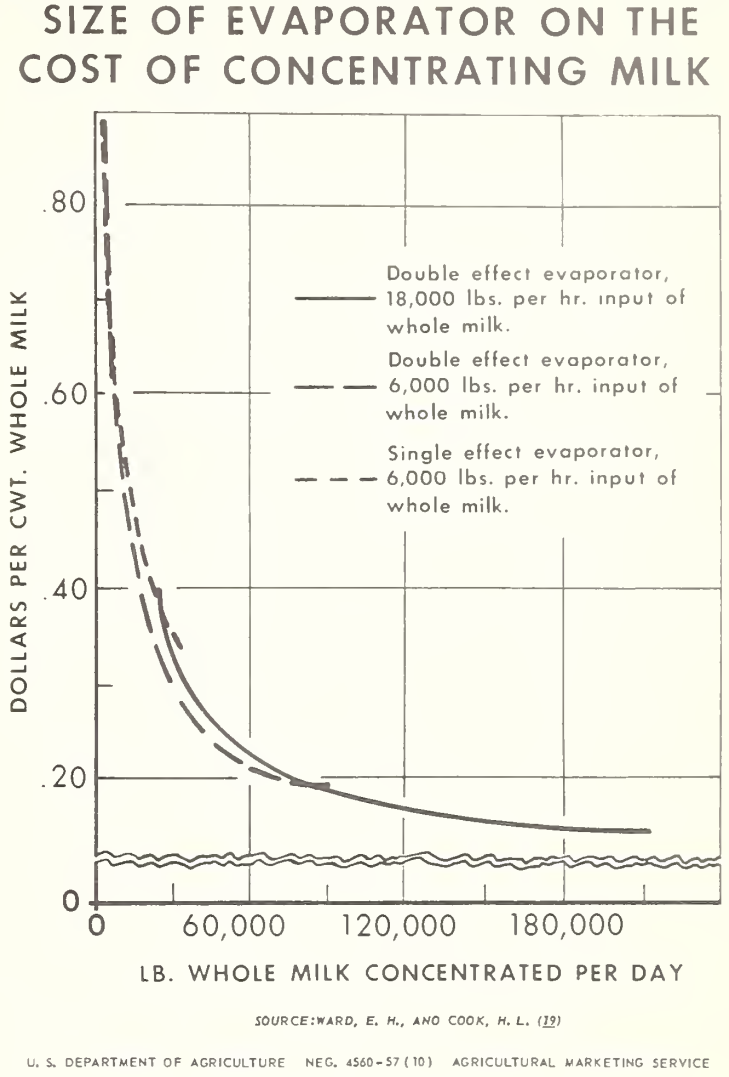
1/ Reduction in producer prices applies only to sales through stores.

2/ A quantity discount of 2 cent per unit is given when home-delivered sales to one purchaser during one month amount to more than 77 units.

3/ Multiunit discounts amounted to 2.5 cents per quart at stores of which 1.25 cents were absorbed by producer and the balance by distributors.

4/ Estimates were made of costs and margins to obtain a basis for estimating the consumer's price.

Figure 2


EFFECT OF VOLUME OUTPUT AND SIZE OF EVAPORATOR ON THE COST OF CONCENTRATING MILK
DOLLARS PER CWT. WHOLE MILK
.80
.60
.40
.20
0
Double effect evaporator, 18,000 lbs. per hr. input of whole milk.
Double effect evaporator, 6,000 lbs. per hr. input of whole milk.
Single effect evaporator, 6,000 lbs. per hr. input of whole milk.
0
60,000
120,000
180,000
LB. WHOLE MILK CONCENTRATED PER DAY
SOURCE: WARD, E. H., AND COOK, H. L. (19)
U. S. DEPARTMENT OF AGRICULTURE NEG. 4560-57 (10) AGRICULTURAL MARKETING SERVICE

In general, the major supplies for individual markets are obtained from the adjacent milkshed. Concentrated milk from manufacturing areas would tend to displace the milk of producers close to the consuming areas who were supplying plants processing fresh whole milk.

Displaced Class I milk ultimately could become available in sufficient quantities to make it possible to establish efficient concentrated milk operations in the milksheds now serving consuming markets.

The factor finally deciding location may be the comparative advantage for dairying in the supply areas for consuming markets relative to that in the manufacturing milk areas.

In order to obtain economical transportation from manufacturing areas, bulk concentrated milk must move in tank-truck or tank-car lots, a minimum of about 30,000 pounds per shipment. This is a very large amount of new product for one city to absorb, amounting to about 5 percent of Washington, D. C., daily needs for fresh whole milk. During an introductory period, it probably would be necessary to obtain outlets in more than one city to move 30,000 pounds of concentrated milk daily. Therefore, initially the marketing problem for a 216,000-pound daily concentrating plant would be difficult and would favor smaller plants operating at higher costs.

Ward and Cook point out that concentrated milk may be moved already packaged at about 13.2 percent higher transportation costs than bulk concentrate (19, pp. 27-28). Should concentrated milk sales on a large scale occur in this fashion, concentrated milk in nearby cities could be delivered directly to stores. In larger and distant cities, deliveries could be made to jobbing firms or to dairies which could deliver at homes or stores.

Should sterile concentrated milk or instant whole milk powder develop, they might well move from processor to consumer through regular wholesale grocery channels and through the direct sales systems of major dairy concerns, rather than by means of home delivery and store routes of local dairy plants. A development of this kind would be encouraged should local dairy firms be reluctant to market the new products at competitive prices. Processors in the milk marketing areas could be expected to seek direct outlets among chainstores and wholesale-grocery concerns. Even a small percentage loss of sales by local dairies could have significant repercussions on the structure of the fluid milk industry, unless such losses occurred so slowly that they were offset by population gains. 9/ If 5 percent of the present national fluid milk sales were shifted from local dairies to direct sales to grocery channels, this would annually amount to about 231 million dollars in sales by local dairy firms. Because the growth of concentrated milk sales would be likely to occur most heavily in relatively few cities, the effect on local dairies and other businesses in such cities could be significant.

CONSUMER ACCEPTANCE OF CONCENTRATED MILK

Flavor

Market experience in 1950-51, and the Armed Services' experiments with concentrated milk, show that consumers will accept and use refrigerated concentrated milk after reconstitution about as readily as whole milk (12).

Research at several colleges has indicated that many consumers cannot distinguish differences in flavor between fresh whole milk and refrigerated or frozen concentrated milk, after reconstitution, and that the great majority of

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9/ U. S. population is increasing about 1.8 percent per year at present.

consumers readily accept refrigerated concentrated milk (5, 9, 13, 14). These results were supported by research by the Army, which showed that there was no statistical significance between the acceptability of fresh whole milk and reconstituted concentrated milk served to troops at Fort Bliss, Tex. (10).

The most recent research on the subject showed that nearly two-thirds of families trying concentrated milk for drinking purposes liked it as well or better than fresh whole milk (5). Above 90 percent of families using the concentrated milk for other purposes, such as cooking, baking, coffee cream, and cereal and dessert liked it as well or better than fresh whole milk or fluid cream.

Reconstituted concentrated milk differs in flavor and viscosity from fresh whole milk, but on the whole these differences are small enough not to affect acceptance. In a Wisconsin study, about one-fourth of the families using concentrated milk for drinking purposes criticized it for flavor reasons (5).

Similar experience or research regarding flavor is not available for sterile concentrated milk and instant whole milk. Evaporated milk, which is a 2-1 sterile concentrated milk, has a distinct caramel flavor. Within the past few years, a so-called "fresh-tasting" evaporated milk has been placed on the market. It has a lesser, but still definite cooked flavor. New processes are being tested that may afford sterile concentrated milk more nearly comparable in flavor with fresh whole milk. A Canadian patent has been issued recently for a process by which, it is claimed, sterile milk can be produced without a cooked flavor and that such milk will not develop a stale flavor (7). However, an instant dry whole milk has not yet been developed that will maintain a satisfactory fresh flavor long enough to permit sale without refrigeration through store channels.

Convenience

The attributes of concentrated milks that make them more convenient to consumers are their small bulk and longer keeping qualities, as compared with fresh whole milk. 10/ Particularly for large families, or those with a restricted amount of refrigeration space, 3-1 concentrate offers easier storability. The keeping quality is adequate to make it possible to buy milk less frequently than is customary with whole milk, and to take advantage of quantity discounts or lower prices at stores.

On the other hand, concentrated milk used for drinking must be reconstituted, and this is an inconvenience. In the Wisconsin study, already cited, one-third of the housewives using concentrated milk for drinking purposes

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10/ While many consumer responses to survey questions indicated an opinion that concentrated milk has longer keeping quality than fresh whole milk, research findings on this point are not conclusive. Improved keeping qualities probably are attributable chiefly to the extra heat treatments concentrated milk receives.

considered it less convenient than fresh whole milk (5). In all uses, 24 percent thought concentrated milk less convenient than fresh whole milk, while 23 percent thought it more convenient. Presumably, the remaining 53 percent considered that the advantages just balanced disadvantages.

A truly sterile concentrate packaged in cans or an instant dry whole milk would not require refrigeration. These products thus would have the advantage of requiring less expensive storage and shelf space than refrigerated or frozen concentrated milk and of possessing a long shelf life..

Market Acceptance

The close balance between convenience and inconvenience of concentrated milk reported in the above survey is an indication that price advantages will be necessary to obtain its market acceptance.

Some measure of market acceptance for concentrated milk is available from the experience of the 1950's. Parker and Harris summarized the results of the introduction of concentrated milk into 7 Federal order markets (12). In these markets concentrated milk was sold at approximately the same price as the equivalent 3 quarts of whole milk. Initially, concentrated milk achieved a small degree of popularity which soon faded so that in 1953, when the article was written, sales were negligible (table 2).

Table 2.--Sales of concentrated milk in milk markets under Federal orders, December 1950-April 1953

Market	Month introduced	Number of months sold	Peak sales	
			Number of months after introduction	Percent of all milk sold 1/
Lima, Ohio	December 1950	7	2	4.80
Boston, Mass	March 1951	2/26	2	2.40
Worcester, Mass	March 1951	25	3	.79
Fall River, Mass	April 1951	13	3	.15
Lowell-Lawrence, Mass.	April 1951	20	4	.40
Minneapolis-St. Paul, Minn.	August 1951	18	7	.28
Philadelphia, Pa.	November 1951	2/18	13	.80

1/ Milk used to make concentrated milk as percentage of whole milk sold in marketing area.

2/ A small amount of concentrated milk sold in April 1953, last month for which reports are available.

Computed from reports of market administrators.

Experience was similar in Washington, D. C., where 1 quart of concentrated milk sold at 3 cents below the price of 3 quarts of whole milk.

Safeway Stores introduced the product to Los Angeles and San Francisco with considerable publicity. In Los Angeles, concentrated milk has sold at 2 1/3 cents per quart of whole milk equivalent below the store price of whole milk (4 1/3 cents under price at homes) (1). Bartlett reports sales to have reached about 15 percent of the whole milk sales in the same stores.

In San Francisco, under similar conditions, with a 3-cent differential below the store price of milk (5 cents under the price at homes), sales have stabilized at about 25 percent of all milk sales at the same stores. Since Safeway sells a small proportion of the milk purchased in these markets, a much smaller percentage of all milk in these markets is concentrated milk.

In Central Iowa and Central Illinois, experimental routes were developed to serve rural householders with concentrated milk (18). Sales were made at the same equivalent prices as local sales of whole milk. Deliveries were made once per week. The Iowa routes served about every fourth household on the routes, or roughly 25 percent of the potential buyers. The Illinois routes were abandoned after competition from several firms developed. Households were too widely dispersed and the routes could not support several competing companies.

Cook and Halvorsen's survey indicated that in Madison and Beloit, Wis., with an assumed price of 20 cents per quart for fresh whole milk, the sale of concentrated milk at 18 cents per quart of milk equivalent would cause about half of the interviewed housewives to buy refrigerated concentrated milk instead of fresh whole milk (5). At 20 cents for concentrated milk, 34 percent would buy it instead of fresh whole milk. The researchers pointed out that these housewives had been conditioned for the survey by receiving at no cost up to 8 quarts of refrigerated concentrated milk. Their attitude might have been less receptive without such initial preparation.

Recently, concentrated milk has been introduced into 27 Wisconsin markets at about 3 cents per quart of milk equivalent below the price of fresh whole milk. Information is not available as yet regarding the volume of these concentrated milk sales.

The results of the various market trials show that:

1. With prices about the same for both concentrated and fresh whole milk, the conveniences of storing, longer keeping qualities, etc. were insufficient to offset the inconveniences of reconstituting the concentrated milk and consumer inertia towards acceptance of a new product.

2. Where concentrated milk is available at a substantial discount below whole milk, a portion of sales of milk will be concentrated milk. However, it is significant that the sale of concentrated milk stabilized without capturing a major part of the sales in

Safeway Stores, even with substantial discounts. It is possible that by completely rationalizing distribution of concentrated milk to obtain all possible cost advantages, the price differential below whole milk prices might be increased to the point that use of concentrated milk would become greater than is indicated by past market experience.

3. It is apparent that special conditions may exist under which sale of milk is feasible only if it is concentrated. Such conditions may include availability of storage space, need for longer keeping ability than whole milk, dispersed routes which make individual deliveries expensive, excessive transportation costs for whole milk, etc.

At least one commercial firm is actively interested in the possibilities of concentrated milk for developing consumption of milk outside of the home--as a beverage in competition with soft drinks, coffee, etc. sold at counters and through vending machines. This company has developed a milk dispenser which automatically reconstitutes concentrated milk by the drink. If successful, this dispenser would sharply lower the costs of servicing and serving milk dispensers and vending machines. Undoubtedly, milk could be made available in many places where now its sale is not economically feasible.

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